2-CHLOROBENZALMALONONITRILE

HSDB - Hazardous Substances Data Bank

0.0 ADMINISTRATIVE INFORMATION

Hazardous Substances Data Bank Number: 4346

Last Revision Date: 20000208

Review Date: Reviewed by SRP on 9/24/1992

Update History:

1. Complete Update on 02/08/2000, 1 field added/edited/deleted.
2. Complete Update on 01/11/2000, 13 fields added/edited/deleted.
3. Field Update on 09/21/1999, 1 field added/edited/deleted.
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20. Field Update on 09/04/1992, 1 field added/edited/deleted.
21. Complete Update on 04/27/1992, 1 field added/edited/deleted.
22. Complete Update on 01/28/1992, 1 field added/edited/deleted.
23. Complete Update on 11/06/1991, 40 fields added/edited/deleted.
24. Field Update on 10/01/1991, 1 field added/edited/deleted.
25. Complete Update on 10/04/1990, 2 fields added/edited/deleted.
26. Field Update on 01/15/1990, 1 field added/edited/deleted.
27. Complete Update on 01/11/1990, 2 fields added/edited/deleted.
28. Complete Update on 01/27/1989, 1 field added/edited/deleted.
29. Complete Update on 12/09/1988, 2 fields added/edited/deleted.
30. Complete Update on 09/23/1988, 1 field added/edited/deleted.

1.0 SUBSTANCE IDENTIFICATION

Name of Substance: 2-CHLOROBENZALMALONONITRILE

CAS Registry Number: 2698-41-1

Related HSDB Records: [MALONONITRILE] (Degradation product)

Synonyms:

1. ((2-Chloro-phenyl)methylene)propanenitrile [Peer reviewed] [Budavari, S. (ed.). The Merck Index - Encyclopedia of Chemicals, Drugs and Biologicals. Rahway, NJ: Merck and Co., Inc., 1989. 328]
2. (O-CHLOROBENZAL)MALONONITRILE [Peer reviewed] [U.S. Department of Health and Human Services, Public Health Service, Center for Disease Control, National Institute for Occupational Safety Health. Registry ofToxic Effects of Chemical Substances (RTECS). National Library of Medicine's current MEDLARS file.,p. 83/8209]
3. 2-CHLOROBENZYLIDENE MALONONITRILE [Peer reviewed] [U.S. Department of Health and Human Services, Public Health Service, Center for Disease Control, National Institute for Occupational Safety Health. Registry ofToxic Effects of Chemical Substances (RTECS). National Library of Medicine's current MEDLARS file.,p. 83/8111]
4. 2-CHLOROBMN [Peer reviewed] [U.S. Department of Health and Human Services, Public Health Service, Center for Disease Control, National Institute for Occupational Safety Health. Registry ofToxic Effects of Chemical Substances (RTECS). National Library of Medicine's current MEDLARS file.,p. 83/8111]
5. BETA,BETA-DICYANO-O-CHLOROSTYRENE [Peer reviewed] [U.S. Department of Health and Human Services, Public Health Service, Center for Disease Control, National Institute for Occupational Safety Health. Registry ofToxic Effects of Chemical Substances (RTECS). National Library of Medicine's current MEDLARS file.,p. 83/8111]
6. CS [Peer reviewed] [U.S. Department of Health and Human Services, Public Health Service, Center for Disease Control, National Institute for Occupational Safety Health. Registry ofToxic Effects of Chemical Substances (RTECS). National Library of Medicine's current MEDLARS file.,p. 83/8111]
7. CS (LACRIMATOR) [Peer reviewed]
8. MALONONITRILE, (O-CHLOROBENZYLIDENE)- [Peer reviewed]
9. NCI-C55118 [Peer reviewed] [U.S. Department of Health and Human Services, Public Health Service, Center for Disease Control, National Institute for Occupational Safety Health. Registry ofToxic Effects of Chemical Substances (RTECS). National Library of Medicine's current MEDLARS file.,p. 83/8111]
10. O-CHLOROBENZYLIDENE MALONITRILE [Peer reviewed] [U.S. Department of Health and Human Services, Public Health Service, Center for Disease Control, National Institute for Occupational Safety Health. Registry ofToxic Effects of Chemical Substances (RTECS). National Library of Medicine's current MEDLARS file.,p. 83/8209]
11. OCBM [Peer reviewed] [American Conference of Governmental Industrial Hygienists. Documentation of the Threshold Limit Values and Biological Exposure Indices. 5th ed. Cincinnati, OH:American Conference of Governmental Industrial Hygienists, 1986. 124]
12. Ortho-chlorobenzylidene malononitrile [Peer reviewed] [American Conference of Governmental Industrial Hygienists. Documentation of the Threshold Limit Values and Biological Exposure Indices. 5th ed. Cincinnati, OH:American Conference of Governmental Industrial Hygienists, 1986. 124]
13. PROPANEDINITRILE, ((2-CHLOROPHENYL)METHYLENE)- [Peer reviewed]
14. USAF KF-11 [Peer reviewed] [U.S. Department of Health and Human Services, Public Health Service, Center for Disease Control, National Institute for Occupational Safety Health. Registry ofToxic Effects of Chemical Substances (RTECS). National Library of Medicine's current MEDLARS file.,p. 83/8111]

Molecular Formula: C10-H5-Cl-N2 [Peer reviewed]

RTECS Number: NIOSH/OO3675000

2.0 MANUFACTURING/USE INFORMATION

Formulations/Preparations:

Available both unground and ground with 5% silica aerogel or treated Cab-O-Sil. [Peer reviewed] [Sax, N.I. and R.J. Lewis, Sr. (eds.). Hawley's Condensed Chemical Dictionary. 11th ed. New York: Van

Nostrand Reinhold Co., 1987. 263]

Major Uses:

1. IT IS USED PRIMARILY AS AN INCAPACITATING AGENT, BOTH BY MILITARY & LAW ENFORCEMENT PERSONNEL. IT CAN BE DISSEMINATED IN BURNING GRENADES & WEAPON-FIRED PROJECTILES, AS AN AEROSOL FROM THE FINELY DIVIDED SOLID CHEMICAL, OR FROM A SOLUTION OF THE CHEMICAL DISSOLVED IN METHYLENE CHLORIDE OR ACETONE. [Peer reviewed] [American Conference of Governmental Industrial Hygienists. Documentation of the Threshold Limit Values and Biological Exposure Indices. 5th ed. Cincinnati, OH:American Conference of Governmental Industrial Hygienists, 1986. 124]
2. Used as a tear-gas and riot control agent. [Peer reviewed] [Kirk-Othmer Encyclopedia of Chemical Technology. 3rd ed., Volumes 1-26. New York, NY: John Wiley and Sons, 1978-1984.,p. V5 401 (1979)]

3.0 CHEMICAL AND PHYSICAL PROPERTIES

Color/Form:

1. WHITE CRYSTALLINE SOLID [Peer reviewed] [American Conference of Governmental Industrial Hygienists. Documentation of the Threshold Limit Values and Biological Exposure Indices. 5th ed. Cincinnati, OH:American Conference of Governmental Industrial Hygienists, 1986. 124]
2. White crystalline solid. [QC reviewed] [NIOSH. NIOSH Pocket Guide to Chemical Hazards. DHHS (NIOSH) Publication No. 97-140. Washington, D.C. U.S. Government Printing Office, 1997. 62]

Odor:

1. ODOR OF PEPPER [Peer reviewed] [American Conference of Governmental Industrial Hygienists. Documentation of the Threshold Limit Values and Biological Exposure Indices. 5th ed. Cincinnati, OH:American Conference of Governmental Industrial Hygienists, 1986. 124]
2. Peper-like odor. [QC reviewed] [NIOSH. NIOSH Pocket Guide to Chemical Hazards. DHHS (NIOSH) Publication No. 97-140. Washington, D.C. U.S. Government Printing Office, 1997. 62]

Boiling Point: 310-315 DEG C [Peer reviewed] [American Conference of Governmental Industrial Hygienists. Documentation of the Threshold Limit Values and Biological Exposure Indices. 5th ed. Cincinnati, OH:American Conference of Governmental Industrial Hygienists, 1986. 124]

Melting Point: 93-95 DEG C [Peer reviewed] [American Conference of Governmental Industrial Hygienists. Documentation of the Threshold Limit Values and Biological Exposure Indices. 5th ed. Cincinnati, OH:American Conference of Governmental Industrial Hygienists, 1986. 124]

Molecular Weight: 188.62 [Peer reviewed] [U.S. Department of Health and Human Services, Public Health Service, Center for Disease Control, National Institute for Occupational Safety Health. Registry ofToxic Effects of Chemical Substances (RTECS). National Library of Medicine's current MEDLARS file.,p. 83/8111]

Octanol/Water Partition Coefficient: log Kow= 1.849 (est) [Peer reviewed] [USEPA; PCGEMS (Graphical Exposure Modeling System) CLOGP-Version April 1987 (1987)]

Solubilities:

1. INSOLUBLE IN WATER [Peer reviewed] [American Conference of Governmental Industrial Hygienists. Documentation of the Threshold Limit Values and Biological Exposure Indices. 5th ed. Cincinnati, OH:American Conference of Governmental Industrial Hygienists, 1986. 124]
2. Soluble in acetone, dioxane, methylene chloride, ethyl acetate, benzene [Peer reviewed] [Budavari, S. (ed.). The Merck Index - Encyclopedia of Chemicals, Drugs and Biologicals. Rahway, NJ: Merck and Co., Inc., 1989. 328]

Vapor Pressure: 3.4X10-5 mm Hg at 20 deg C [Peer reviewed] [Budavari, S. (ed.). The Merck Index - Encyclopedia of Chemicals, Drugs and Biologicals. Rahway, NJ: Merck and Co., Inc., 1989. 328]

Other Chemical/Physical Properties:

Henry's Law constant= 1.02X10-8 atm-cu m/mole (est). [Peer reviewed] [SRC; Hine J, Mookerjee PK; J Org Chem 40: 292-8 (1975)]

4.0 SAFETY AND HANDLING

EMERGENCY GUIDELINES ▲

Hazards Summary:

The major hazards encountered in the use and handling of 2-chlorobenzalmalononitrile stem from its toxicologic properties. Toxic primarily by inhalation and dermal contact, exposure to this pepper-smelling, white crystalline substance may occur from its production or use as an incapacitating agent by military and law enforcement personnel. Effects from exposure may include lacrimation, headache, contact burns to the eyes and skin, bronchospasm, laryngospasm, hypersensitivity reactions, and pulmonary edema. Some effects may be delayed. OSHA has established a Ceiling exposure limit of 0.4 mg/cu m for this substance. If contact should occur, irrigate exposed eyes with copious amounts of tepid water for at least 15 minutes, and wash exposed skin thoroughly with soap and water. [Peer reviewed]

HAZARDOUS REACTIONS ▲

Reactivities and Incompatibilities:

Strong oxidizers. [QC reviewed] [NIOSH. NIOSH Pocket Guide to Chemical Hazards. DHHS (NIOSH) Publication No. 97-140. Washington, D.C. U.S. Government Printing Office, 1997. 62]

Decomposition:

When heated to decomposition it emits very toxic fumes of /hydrogen chloride, nitrogen oxides and cyanides./ [Peer reviewed] [Sax, N.I. Dangerous Properties of Industrial Materials. 6th ed. New York, NY: Van Nostrand Reinhold, 1984. 681]

WARNING PROPERTIES ▲

Skin, Eye and Respiratory Irritations:

1. A human skin, eye irritant. [Peer reviewed] [Sax, N.I. Dangerous Properties of Industrial Materials. 6th ed. New York, NY: Van Nostrand Reinhold, 1984. 681]
2. Human volunteers experienced greater ocular and respiratory irritation from 0.9 u than from 60 u particles. However, with the larger particles the ocular irritation predominated and required a longer recovery time than with the smaller particles. [Peer reviewed] [Grant, W.M. Toxicology of the Eye. 3rd ed. Springfield, IL: Charles C. Thomas Publisher, 1986. 209]

PREVENTIVE MEASURES ▲

Protective Equipment and Clothing:

1. Wear appropriate personal protective clothing to prevent skin contact. [QC reviewed] [NIOSH. NIOSH Pocket Guide to Chemical Hazards. DHHS (NIOSH) Publication No. 97-140. Washington, D.C. U.S. Government

Printing Office, 1997. 62]

2. Wear appropriate eye protection to prevent eye contact. [QC reviewed] [NIOSH. NIOSH Pocket Guide to Chemical Hazards. DHHS (NIOSH) Publication No. 97-140. Washington, D.C. U.S. Government Printing Office, 1997. 62]
3. Any supplied-air respirator with a full facepiece. Recommendations for respirator selection. Max concn for use: 2 mg/cu m: Respirator Classes: Any supplied-air respirator operated in a continuous flow mode. Eye protection needed. Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern and having a high-efficiency particulate filter. Any self-contained breathing apparatus with a full facepiece. [QC reviewed] [NIOSH. NIOSH Pocket Guide to Chemical Hazards. DHHS (NIOSH) Publication No. 97-140. Washington, D.C. U.S. Government Printing Office, 1997. 62]
4. Recommendations for respirator selection. Condition: Emergency or planned entry into unknown concn or IDLH conditions: Respirator Classes: Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive pressure mode. Any supplied-air respirator with a full face piece and operated in pressure-demand or other positive pressure mode in combination with an auxiliary self-contained breathing apparatus operated in pressure-demand or other positive pressure mode. [QC reviewed] [NIOSH. NIOSH Pocket Guide to Chemical Hazards. DHHS (NIOSH) Publication No. 97-140. Washington, D.C. U.S. Government Printing Office, 1997. 62]
5. Recommendations for respirator selection. Condition: Escape from suddenly occurring respiratory hazards: Respirator Classes: Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern and having a high-efficiency particulate filter. Any appropriate escape-type, self-contained breathing apparatus. [QC reviewed] [NIOSH. NIOSH Pocket Guide to Chemical Hazards. DHHS (NIOSH) Publication No. 97-140. Washington, D.C. U.S. Government Printing Office, 1997. 62]

Other Preventative Measures:

1. The worker should immediately wash the skin when it becomes contaminated. [QC reviewed] [NIOSH. NIOSH Pocket Guide to Chemical Hazards. DHHS (NIOSH) Publication No. 97-140. Washington, D.C. U.S. Government Printing Office, 1997. 62]
2. The worker should wash daily at the end of each work shift. [QC reviewed] [NIOSH. NIOSH Pocket Guide to Chemical Hazards. DHHS (NIOSH) Publication No. 97-140. Washington, D.C. U.S. Government Printing Office, 1997. 62]
3. Work clothing that becomes wet or significantly contaminated should be removed or replaced. [QC reviewed] [NIOSH. NIOSH Pocket Guide to Chemical Hazards. DHHS (NIOSH) Publication No. 97-140. Washington, D.C. U.S. Government Printing Office, 1997. 62]
4. Workers whose clothing may have become contaminated should change into uncontaminated clothing before leaving the work premises. [QC reviewed] [NIOSH. NIOSH Pocket Guide to Chemical Hazards. DHHS (NIOSH) Publication No. 97-140. Washington, D.C. U.S. Government Printing Office, 1997. 62]
5. Contact lenses should not be worn when working with this chemical. [QC reviewed] [NIOSH. NIOSH Pocket Guide to Chemical Hazards. DHHS (NIOSH) Publication No. 97-140. Washington, D.C. U.S. Government Printing Office, 1997. 62]
6. All nitriles should be handled under carefully controlled conditions and only by personnel having a thorough understanding and knowledge of safe handling techniques. Because of the nature of nitrile cmpd and the lack of complete toxicity data on many nitriles, care should be exercised in handling these cmpd to avoid inhalation of the vapors, ingestion, and contact with the skin. /Nitriles/ [Peer reviewed] [International Labour Office. Encyclopedia of Occupational Health and Safety. Vols. I&II. Geneva, Switzerland: International Labour Office, 1983. 1447]
7. SRP: The scientific literature for the use of contact lenses in industry is conflicting. The benefit or detrimental effects of wearing contact lenses depend not only upon the substance, but also on factors including the form of the substance, characteristics and duration of the exposure, the uses of other eye protection equipment, and the hygiene of the lenses. However, there may be individual substances whose irritating or corrosive properties are such that the wearing of contact lenses would be harmful to the eye. In those specific cases, contact lenses should not be worn. In any event, the usual eye protection equipment should be worn even when contact lenses are in place. [QC reviewed]

OTHER SAFETY AND HANDLING ▲

Cleanup Methods:

1. 1. VENTILATE AREA OF SPILL. 2. FOR SMALL QUANTITIES, SWEEP ONTO PAPER OR OTHER SUITABLE MATERIAL, PLACE IN APPROPRIATE CONTAINER & BURN IN SAFE PLACE (SUCH AS FUME HOOD). LARGE QUANTITIES MAY BE RECLAIMED; HOWEVER, IF THIS IS NOT PRACTICAL, DISSOLVE IN FLAMMABLE SOLVENT (SUCH AS ALCOHOL) & ATOMIZE IN SUITABLE COMBUSTION CHAMBER EQUIPPED WITH APPROPRIATE EFFLUENT GAS CLEANING DEVICE. 3. DECONTAMINATE AREA OF SPILL: (A) BY WASHING WITH A 5% SOLUTION OF SODIUM HYDROXIDE IN 50/50 ETHYL ALCOHOL/WATER; OR (B) BY ADDING FLAKE SODIUM HYDROXIDE TO A SOLUTION OR SLURRY OF THE SPILL IN ISOPROPYL ALCOHOL; OR (C) BY COVERING THE SPILL WITH A 10% SOLUTION OF SODIUM HYDROXIDE IN 50/50 ISOPROPYL ALCOHOL/WATER & LETTING STAND 20 MINUTES BEFORE FLUSHING WITH WATER. [Peer reviewed] [Mackison, F. W., R. S. Stricoff, and L. J. Partridge, Jr. (eds.). NIOSH/OSHA - Occupational Health Guidelines for Chemical Hazards. DHHS(NIOSH) PublicationNo. 81-123 (3 VOLS). Washington, DC: U.S. Government Printing Office, Jan. 1981.]
2. CHEMICAL DISPOSAL METHOD FOR CS WAS DEVELOPED. THE RECOMMENDED REACTION IS AQ ALKALINE HYDROLYSIS OF CS TO O-CHLOROBENZALDEHYDE. [Peer reviewed] [BROOKS ME ET AL; US NTIS, AD REPORT AD-A033469 (1976)]

Disposal Methods:

1. A poor candidate for incineration. /Cyanides/ [Peer reviewed] [USEPA; Engineering Handbook for Hazardous Waste Incineration p.3-8 (1981) EPA 68-03-3025]
2. 1. BY MAKING PACKAGES OF O-CHLOROBENZYLIDENE MALONONITRILE IN PAPER OR OTHER FLAMMABLE MATERIAL & BURNING IN SUITABLE COMBUSTION CHAMBER EQUIPPED WITH AN APPROPRIATE EFFLUENT GAS CLEANING DEVICE. 2. BY DISSOLVING O-CHLOROBENZYLIDENE MALONONITRILE IN FLAMMABLE SOLVENT (SUCH AS ALCOHOL) & ATOMIZING IN SUITABLE COMBUSTION CHAMBER EQUIPPED WITH APPROPRIATE EFFLUENT GAS CLEANING DEVICE. 3. BY MIXING SOLID WITH 5 PARTS OF 10% SOLUTION OF MONOETHANOLAMINE IN WATER CONTAINING 0.3% OF NONIONIC DETERGENT. 4. BY STIRRING 1 LB OF SOLID FOR 2 HOURS IN 1 GALLON OF A 5-15% SOLUTION OF SODIUM HYDROXIDE IN ETHYLENE GLYCOL, ETHYL ALCOHOL, OR METHYL ALCOHOL. [Peer reviewed] [Mackison, F. W., R. S. Stricoff, and L. J. Partridge, Jr. (eds.). NIOSH/OSHA - Occupational Health Guidelines for Chemical Hazards. DHHS(NIOSH) PublicationNo. 81-123 (3 VOLS). Washington, DC: U.S. Government Printing Office, Jan. 1981.]
3. Generators of waste (equal to or greater than 100 kg/mo) containing this contaminant, EPA hazardous waste numbers D003 and P030 must conform with USEPA regulations in storage, transportation, treatment and disposal of waste. /Cyanide cmpd and Cyanides, not otherwise specified/ [Peer reviewed] [40 CFR 240-280, 300-306, 702-799 (7/1/91)]

5.0 TOXICITY/BIOMEDICAL EFFECTS

SUMMARY ▲

Antidote and Emergency Treatment:

1. Rapid support of respiration and circulation is essential to successful treatment of cyanide intoxication. Massive cyanide overdoses have survived with only good supportive care. Immediate attention should be directed toward assisted ventilation, administration of 100% oxygen, insertion of intravenous lines, and institution of cardiac monitoring. Obtain an arterial blood gas immediately and correct any severe metabolic acidosis (pH below 7.15). Oxygen (100%) should be used routinely in moderate or severely symptomatic patients even in the presence of a

normal pO2, since 100% O2 increases O2 delivery, may reactivate cyanide-inhibited mitochondrial enzymes, and potentiates the effect of thiosulfate. Avoid mouth to mouth resuscitation during CPR in order to prevent self poisoning. /Cyanides/ [Peer reviewed] [Ellenhorn, M.J. and D.G. Barceloux. Medical Toxicology - Diagnosis and Treatment of Human Poisoning. New York, NY: Elsevier Science Publishing Co., Inc. 1988. 833]

2. Amyl nitrite perles are designed to produce 3% to 5% methemoglobinemia while an iv line is established for iv sodium nitrite. As a temporizing measure, the patient inhales the vapors until the sodium nitrite is ready. Because of the variability in methemoglobin production and the potential for cardiovascular collapse, this step may be omitted if sodium nitrite is readily available and the patient is not in extremis. Adequate ventilation and oxygenation are more important than administration of amyl nitrite. One perle (0.2 ml) is crushed and inhaled for 30 seconds every minute until iv nitrite is given. Sodium nitrite (3% solution), as 10 ml of a 3% solution (eg, 300 mg), is administered iv slowly over 4 minutes to produce a 20% methemoglobin level in adults. Children should receive 0.33 ml of the 3% solution per kilogram initially at an infusion rate of 2.5 ml/min, up to a maximum of 10 ml. Administer sodium nitrite doses to children on the basis of body weight, since fatal methemoglobinemia has occurred in children. /Cyanides/ [Peer reviewed] [Ellenhorn, M.J. and D.G. Barceloux. Medical Toxicology - Diagnosis and Treatment of Human Poisoning. New York, NY: Elsevier Science Publishing Co., Inc. 1988. 833]

TOXICITY EXCERPTS ▲

Human Toxicity Excerpts:

1. ... HUMAN VOLUNTEERS /WERE EXPOSED/ TO CS AEROSOLS DISPERSED FROM A 10% SOLUTION IN METHYLENE CHLORIDE, OR FROM PURE MOLTEN COMPOUND. ... 3 OF 4 MEN EXPOSED FOR 90 MINUTES AT 1.5 MG/CU M CS DEVELOPED HEADACHES, & 1 ... DEVELOPED SLIGHT EYE & NOSE IRRITATION. TWO ... EXPERIENCED HEADACHE FOR 24 HR FOLLOWING EXPOSURE. ... INCREASING TEMPERATURE & RELATIVE HUMIDITY AS WELL AS HYPERVENTILATION CAUSED DECREASE IN TOLERANCE TIME TO CS EFFECTS. MAJOR EXPOSURE SYMPTOMS WERE EYE IRRITATION, CONJUNCTIVITIS, LACRIMATION & SKIN BURNING. [Peer reviewed] [American Conference of Governmental Industrial Hygienists. Documentation of the Threshold Limit Values and Biological Exposure Indices. 5th ed. Cincinnati, OH:American Conference of Governmental Industrial Hygienists, 1986. 124]
2. TWENTY FIVE OF 28 WORKERS IN A CHEMICAL PLANT MANUFACTURING ORTHO-CHLOROBENZYLIDENE MALONONITRILE GAVE A HISTORY OF DERMATITIS INVOLVING THE ARMS AND NECK. TWO OF 25 WORKERS SHOWED POSITIVE PATCH TEST REACTIONS WHEN TESTED TO A 1:1000 DILUTION OF ORTHO-CHLOROBENZYLIDENE MALONONITRILE IN OLIVE OIL. [Peer reviewed] [SHMUNES E, TAYLOR JS; ARCH DERMATOL 107 (2): 212 (1973)]
3. PULMONARY EDEMA COMPLICATED BY PNEUMONIA, HEART FAILURE & HEPATOCELLULAR DAMAGE WERE OBSERVED IN A 43 YR OLD MALE EXPOSED TO CS TEAR GAS. [Peer reviewed] [KRAPF R, THALMANN H; SCHWEIZ MED WOCHENSCHR 111 (52): 2056 (1981)]
4. A 4 MO OLD MALE INFANT DEVELOPED PNEUMONITIS FOLLOWING A PROLONGED EXPOSURE TO TEAR GAS. THE PAIENT HAD A PERSISTENT LEUKOCYTOSIS (WHITE BLOOD CELL COUNT 20000 TO 30000/CU MM) WITH A PREDOMINANCE OF LYMPHOCYTES ON PERIPHERAL BLOOD SMEAR. [Peer reviewed] [PARK S, GIAMMONA ST; AM J DIS CHILD 123 (3): 245 (1972)]
5. ... A SIGNIFICANT SKIN SENSITIZING POTENTIAL TO CS EXISTS IN INDUSTRY WHERE THIS CHEMICAL IS HANDLED. THE RESULTING DERMATITIS INVOLVES MAINLY THE ARMS & NECKS. [Peer reviewed] [American Conference of Governmental Industrial Hygienists. Documentation of the Threshold Limit Values and Biological Exposure Indices. 5th ed. Cincinnati, OH:American Conference of Governmental Industrial Hygienists, 1986. 124]

Non-Human Toxicity Excerpts:

1. THE LETHAL CONCENTRATION OF 2-CHLOROBENZALMALONONITRILE TO RAINBOW TROUT WAS MORE THAN 0.1 MG/L FOR AN EXPOSURE PERIOD OF LESS THAN 1 WK. [Peer reviewed] [ABRAM FSH, WILSON P; WATER RES 13 (7): 631 (1979)]
2. IN ACUTE EXPOSURES OF RATS TO 2-CHLOROBENZALMALONONITRILE, BOTH THE CORTICAL

& MEDULLARY REGIONS OF THE ADRENAL GLANDS SHOWED SIGNIFICANT CYTOCHEMICAL CHANGES. IP INJECTIONS OF 10 MG/KG & 20 MG/KG PRODUCED INCREASE IN PERIODIC ACID-SCHIFF, SUDANOPHILIC & ALKALINE PHOSPHATASE REACTIONS. [Peer reviewed] [CHOWDHURY AR ET AL; MIKROSKOPIE 35 (7-8): 183 (1979)]

3. A DOSE-DEPENDENT INHIBITION OF CYTOCHROME OXIDASE, PYRUVATE DEHYDROGENASE COMPLEX, SUCCINATE DEHYDROGENASE, LACTATE DEHYDROGENASE, MALATE DEHYDROGENASE, & GLUTAMATE DEHYDROGENASE WAS OBSERVED IN RATS ADMINISTERED 10 MG/KG & 20 MG/KG, IP. IT ALSO HAS A STIMULATING EFFECT ON THE LACTIC ACID FORMATION IN RAT BRAIN DURING GLYCOLYSIS. [Peer reviewed] [DUBE SN; INDIAN J EXP BIOL 18 (1): 80 (1980)]
4. DAILY DOSES OF 8 & 16 MG/KG FOR 10 DAYS TO MICE SUPPRESSED THE HUMORAL IMMUNE RESPONSE TO SHEEP RED BLOOD CELLS. IN ADDITION TO THE DIRECT EFFECT, INCREASED CORTICOSTERONE LEVELS AT 16 MG/KG MAY BE INSTRUMENTAL IN BRINGING ABOUT IMMUNOSUPPRESSION. [Peer reviewed] [NAGARKATTI M ET AL; TOXICOL LETT 8 (1-2): 73 (1981)]
5. MUTAGENICITY OF O-CHLOROBENZYLIDENE MALONONITRILE WAS TESTED IN AMES SALMONELLA/MICROSOME ASSAY WITH STRAINS TA 1535, TA 1537, TA 1538, TA 98, & TA 100. WITHOUT PREINCUBATION DOUBLING OF REVERTANTS WAS SEEN IN STRAIN TA 100 AT CONCENTRATIONS OF 1000 & 2000 UG/PLATE. A SLIGHT INCREASE OCCURRED WITH PREINCUBATION IN TA 100 AT CONCENTRATIONS OF 100 & 500 UG. [Peer reviewed] [VON DAENIKEN A ET AL; ARCH TOXICOL 49 (1): 15 (1981)]
6. FOLLOWING EXPOSURE TO 150 MG/CU M O-CHLOROBENZYLIDENE MALONONITRILE FOR 2 HR, 2 ANIMALS (HAMSTERS) OUT OF 240 DIED OF BRONCHOPNEUMONIA. EXPOSURE OF 106 HAMSTERS AND 120 RATS TO 480 MG/CU M RESULTED IN THE DEATHS OF 31 HAMSTERS AND 9 RATS. ANIMALS THAT DIED WITHIN 48 HR OF EXPOSURE HAD MODERATELY SEVERE PULMONARY CONGESTION, HEMORRHAGES AND OCCASIONALLY EDEMA. ACUTE RENAL CORTICAL AND MEDULLARY TUBULAR NECROSIS WAS A COMMON FINDING. IN SOME RATS THERE WAS MIDZONAL HEPATOCELLULAR NECROSIS. [Peer reviewed] [BALLANTYNE B, CALLAWAY S; MED SCI LAW 12 (1): 43 (1972)]
7. PYROTECHNICALLY GENERATED (GRENADE) O-CHLOROBENZYLIDENE MALONONITRILE WAS GIVEN BY INHALATION TO CATS IN CONCN BETWEEN 460 AND 1040 MG/CU M FOR 1 HR. RESP DEPRESSION, POSSIBLY REFLEX IN NATURE, REGULARLY OCCURRED WHEN THE MATERIAL WAS GIVEN VIA THE UPPER RESP TRACT, AND RESP STIMULATION OCCURRED WHEN IT WAS GIVEN VIA TRACHEAL CANNULA. [Peer reviewed] [BRIMBLECOMBE RW ET AL; BRIT J PHARMACOL 44 (3): 561 (1972)]
8. O-CHLOROBENZYLIDENE MALONONITRILE PRODUCED A 50% DEPRESSION OF RESP RATE IN MICE AFTER A 1 MIN EXPOSURE. [Peer reviewed] [BALLANTYNE B ET AL; CURR APPROACHES TOXICOL: 129 (1977)]
9. RABBIT EYES WERE CONTAMINATED WITH CS IN SOLN (0.5 TO 10% IN POLYETHYLENE GLYCOL 300), AS A SOLID (0.5 TO 5 MG), AND AS A PYROTECHNICALLY GENERATED SMOKE (15 MIN EXPOSURE TO 6 G/CU M). CS CAUSED LACRIMATION, BLEPHARITIS AND CONJUNCTIVAL IRRITATION BY ALL THE METHODS OF CONTAMINATION, THE SEVERITY AND DURATION OF WHICH INCR WITH THE AMT OF MATERIAL APPLIED. [Peer reviewed] [BALLANTYNE B ET AL; ARCH TOXICOL 32 (3): 149 (1974)]
10. NO INCR IN LUNG TUMORS WAS OBSERVED IN MICE OR RATS EXPOSED TO CT'S OF 50 AND 500 MG O-CHLOROBENZYLIDENEMALONONITRILE MIN/CU M 5 DAYS A WEEK FOR 4 WEEKS. EXPOSURE CONCN WERE ABOUT 21 MG/CU M, AND TOTAL CT'S WERE, THUS, 1000 AND 10000 MG MIN/CU M. [Peer reviewed] [MCNAMARA BP ET AL; CS. US NAT TECH INFORM SERV, AD REPORT NO 770365/5GA (1973)]
11. PREGNANT RATS AND RABBITS WERE EXPOSED TO O-CHLOROBENZYLIDENE MALONONITRILE AEROSOLS AT 6, 20, AND 60 MG/CU M FOR 5 MIN ON DAYS 6-15 AND 6-18 OF PREGNANCY, RESPECTIVELY, AND RATS WERE INJECTED IP AT 20 MG/KG ON DAYS 6, 8, 10, 12, OR 14 OF PREGNANCY, BUT IT WAS NOT EMBRYOLETHAL OR TERATOGENIC AND THERE WAS NO EFFECT ON THE NUMBER OF IMPLANTATIONS OR LITTERS PRODUCED. [Peer reviewed] [UPSHALL DG; TOXICOL APPL PHARMACOL 24 (1): 45 (1973)]

12. CS was found to bind to nuclear proteins but not to DNA in rats. In a study in which Sprague Dawley rats were administered an intraperitoneal injection of 13 mg/kg of CS with a (14)C-label at the benzylic carbon, very little radioactivity was found in liver DNA 8 or 75 hours after the animals were dosed. However, a considerable amount of radioactivity was observed in nuclear proteins isolated from liver and kidney at these times. The binding to protein may have occurred between the carbons at the double bond in CS and the sulfhydryl groups of proteins. Additionally, the binding could have occurred between o-chlorobenzaldehyde (a hydrolysis product) and the amino groups of proteins. [Peer reviewed] [DHHS/NTP; Toxicology and Carcinogenesis Studies of CS (94% o-Chlorobenzalmalononitrile) in F344/N Rats and B6C3F1 Mice p.14 (1990) Technical Rpt Series No. 377 NIH Pub No. 90-2832]
13. Results of bacterial mutagenicity assays with CS were generally negative, although there have been reports of equivocal to weakly positive responses observed in Salmonella strain TA100 in the absence of S9 activation and in TA97 with S9. Administration of CS in feed did not result in an increase in sex-linked recessive lethal mutations in germ cells of male Drosophila. In mammalian cell cultures, positive results were reported for gene mutation induction in L5178Y mouse lymphoma cells, and cytogenetic tests conducted by the National Toxicology Program in Chinese hamster ovary cells were positive for induction of sister chromatid exchanges and chromosomal aberrations in the presence and absence of S9. However, no increase /was observed/ in micronucleated polychromatic erythrocyres in the bone marrow of mice administered CS either by intraperitoneal injection or orally. [Peer reviewed] [DHHS/NTP; Toxicology and Carcinogenesis Studies of CS (94% o-Chlorobenzalmalononitrile) in F344/N Rats and B6C3F1 Mice p.14 (1990) Technical Rpt Series No. 377 NIH Pub No. 90-2832]
14. The responses in Salmonella gene mutation tests with 94% o-chlorobenzalmalononitrile (with 5% Cab-O-Sil colloidal silica; 1% hexamethyldisilizane) were equivocal in one laboratory for strain TA100 in the absence of exogenous metabolic activation (S9) and equivocal in another laboratory for TA97 with (S9); in all other strains tested. 94% o-Chlorobenzalmalononitrile (with 5% Cab-O-Sil colloidal silica; 1% hexamethyldisilizane) was clearly negative with or without (S9). 94% o-Chlorobenzalmalononitrile (with 5% Cab-O-Sil colloidal silica; 1% hexamethyldisilizane) induced trifluorothymidine resistance in mouse L5178Y/TK lymphoma cells in the absence of (S9); it was not tested with (S9). 94% o-Chlorobenzalmalononitrile (with 5% Cab-O-Sil colloidal silica; 1% hexamethyldisilizane) induced both sister chromatid exchanges and chromosomal aberrations in CHO cells with and without S(9). [Peer reviewed] [DHHS/NTP; Toxicology and Carcinogenesis Studies of CS (94% o-Chlorobenzalmalononitrile) in F344/N Rats and B6C3F1 Mice p.3 (1990) Technical Rpt Series No. 377 NIH Pub No. 90-2832]
15. STRUCTURE-ACTIVITY RELATIONSHIPS WERE QUALITATIVELY & QUANTITIVELY EXAMINED FOR 56 COMPOUNDS (EG DERIVATIVES OF PROPIONITRILE, ACRYLONITRILE, & CYSTEAMINE) WHICH CAUSED DUODENAL ULCER &/OR ADRENOCORTICAL NECROSIS IN RATS. ULCEROGENIC ACTIVITY WAS MOST INTENSE IN THE CARBONITRILES ATTACHED TO 2 OR 3-C BACKBONES. [Peer reviewed] [SZABO S ET AL; J PHARMACOL EXP THER 223 (1): 68 (1982)]

TOXICITY VALUES ▲

Non-Human Toxicity Values:

1. LD50 Rat iv 28 mg/kg [Peer reviewed] [Budavari, S. (ed.). The Merck Index - Encyclopedia of Chemicals, Drugs and Biologicals. Rahway, NJ: Merck and Co., Inc., 1989. 328]
2. LD50 Rat ip 48 mg/kg [Peer reviewed] [Budavari, S. (ed.). The Merck Index - Encyclopedia of Chemicals, Drugs and Biologicals. Rahway, NJ: Merck and Co., Inc., 1989. 328]
3. LD50 Rat (male) oral 1366 mg/kg [Peer reviewed] [DHHS/NTP; Toxicology and Carcinogenesis Studies of CS (94% o-Chlorobenzalmalononitrile) in F344/N Rats and B6C3F1 Mice p.13 (1990) Technical Rpt Series No. 377 NIH Pub No. 90-2832]
4. LD50 Rat (female) oral 1284 mg/kg [Peer reviewed] [DHHS/NTP; Toxicology and Carcinogenesis Studies of CS (94% o-Chlorobenzalmalononitrile) in F344/N Rats and B6C3F1 Mice p.13 (1990) Technical Rpt Series No. 377 NIH Pub No. 90-2832]

Ecotoxicity Values:

1. LC50 Rainbow trout 1.28 mg/l/12 hr. /Conditions of bioassay not specified/ [Peer reviewed] [Verschueren, K. Handbook of Environmental Data of Organic Chemicals. 2nd ed. New York, NY: Van Nostrand Reinhold Co., 1983. 361]
2. LC50 RAINBOW TROUT > 0.1 MG/L < 1 WK. [Peer reviewed] [ABRAM FSH, WILSON P; WATER RES 13 (7): 631 (1979)]

National Toxicology Program Reports:

1. Toxicology and carcinogenesis studies were conducted by exposing 50 F344/N rats and 50 B6C3F1 mice of each sex to ... (94% o-chlorobenzalmalononitrile) /by inhalation/. ... Exposure concentrations for the 2 yr studies were 0, 0.075, 0.25, or 0.75 mg/cu m for 6 hr/day, 5 days/wk for 105 wk for groups of 50 rats of each sex. Groups of 50 mice of each sex were exposed to 0, 0.75, or 1.5 mg/cu m on the same schedule. ... Under the conclusions of these inhalation studies, there was no evidence of carcinogenic activity ... for male or female F344/N rats exposed to 0.075, 0.25, or 0.75 mg/cu m for 2 yr. There was no evidence of carcinogenic activity for male or female B6C3F1 mice exposed to 0.75 or 1.5 mg/cu m in air for up to 2 yr. [Peer reviewed] [DHHS/NTP; Toxicology and Carcinogenesis Studies of CS2 (94% o-Chlorobenzalmalononitrile) in F344/N Rats and B6C3F1 Mice p.3 (1990) Technical Rpt Series No. 377 NIH Pub No. 90-2832]
2. Toxicology and carcinogenesis studies were conducted by exposing groups of F344/N rats and B6C3F1 mice of each sex for 6 hours per day, 5 days per week for 2 weeks, 13 weeks, or 2 years, to a CS2 (94% o-chlorobenzlmalonitrile [CS]; 5% Cab-O-Sil colloidal silica; 1% hexamethyldissilizane), aerosol. ... No compound-related clinical signs were observed. No significant differences in survival were seen for any group of rats or mice of either sex. ... Compound-related nonneoplastic lesions occurred in the nasal passage of exposed rats and mice. In exposed rats, hyperplasia and squamous metaplasia of the respiratory epithelium and degeneration of the olfactory epithelium with ciliated columnar and/or squamous metaplasia were observed. Focal chronic inflammation and proliferation of the periosteum of the turbinate bones were increased slightly in rats at the top exposure concentration. Suppurative inflammation with hyperplasia and squamous metaplasia of the respiratory epithelium occurred in exposed mice. The were no compound-related increased incidences of neoplasms in rats or mice. ... In exposed female mice, there were pronounced decreases in the incidences of adenomas of the pituitary pars distalis (control, 13/47; 0.75 mg/cu m, 5/46; 1.5 mg/cu m, 1/46) and decreased incidences of malignant lymphomas (21/50; 12/50; 8/50). [Peer reviewed] [DHHS/NTP; Toxicology and Carcinogenesis Studies of CS (94% o-Chlorobenzalmalononitrile) in F344/N Rats and B6C3F1 Mice p.3 (1990) Technical Rpt Series No. 377 NIH Pub No. 90-2832]

PHARMACOKINETICS ▲

Metabolism/Metabolites:

1. ... METABOLITE IN BLOOD OF CATS & RATS, TO WHICH CS, O-CHLOROBENZYLIDENE MALONONITRILE, HAD BEEN ADMINISTERED, HAS ... BEEN /IDENTIFIED/ ... AS O-CHLOROBENZYLMALONONITRILE. REDUCTION OF THE BENZYLIDENE DOUBLE BOND, WHICH OCCURS IN THE ERYTHROCYTE CYTOPLASM, IS ASSOCIATED WITH THE DETOXIFICATION OF CS. [Peer reviewed] [The Chemical Society. Foreign Compound Metabolism in Mammals Volume 3. London: The Chemical Society, 1975. 338]
2. IN RABBITS ADMINISTERED IV DOSES 2 REACTIONS TAKE PLACE HYDROLYSIS & REDUCTION. O-CHLOROBENZALDEHYDE & MALONONITRILE ARE PRODUCTS OF HYDROLYSIS & O-CHLOROBENZYL MALONONITRILE IS PRODUCT OF REDUCTION. BIOTRANSFORMATION TAKES PLACE MAINLY IN THE BLOOD, BUT LIVER, IN CONTRAST TO KIDNEYS, IS ALSO IMPORTANT IN THE TRANSFORMATION. O-CHLOROBENZYLIDENE MALONONITRILE & ITS BASIC METABOLITES, O-CHLOROBENZALDEHYDE & O-CHLOROBENZYL MALONONITRILE HAVE SHORT HALF-LIVES IN THE BLOOD. [Peer reviewed] [PARADOWSKI M; POL J PHARMACOL PHARM 31 (6): 563 (1979)]
3. MICE RECEIVED O-CHLOROBENZYLIDENE MALONONITRILE BY IP INJECTION (0.5 LD50) OR BY AEROSOL EXPOSURE (20000 MG/MIN/CU M). INCREASED EXCRETION OF THIOCYANATE IN THE URINE WAS OBSERVED, INDICATING A TRANSFORMATION OF CS TO CYANIDE IN VIVO. [Peer

reviewed] [FRANKENBERG L, SORBO B; ARCH TOXIKOL 31 (2): 99 (1973)]

4. The fate of (3)H-ring labeled, (14(C-cyanide labeled, and (14C=C) side chain-labeled CS was studied in Porton rats given intraperitoneal or gavage doses ranging from 0.08 to 159 umol/kg. In most cases, the largest proportion (44%-100%) of the dose was eliminated in the urine. The major urinary metabolites identified were 2-chlorohippuric acid, 1-O-(2-chlorobenzyl)glucuronic acid, 2-chlorobenzyl cysteine, and 2-chlorobenzoic acid. Minor metabolites identified included 2-chlorobenzyl alcohol and 2-chlorophenyl-2-cyanopropionate. [Peer reviewed] [DHHS/NTP; Toxicology and Carcinogenesis Studies of CS (94% o-Chlorobenzalmalononitrile) in F344/N Rats and B6C3F1 Mice p.14 (1990) Technical Rpt Series No. 377 NIH Pub No. 90-2832]

Biological Half-Life:

... CATS & RATS /WERE EXPOSED/ TO CS AEROSOL ... ABSORPTION OF THE COMPOUND /OCCURRED/ ... IN THE BLOOD. ... THE HALF-LIFE ... IN THE BLOOD /WAS/ ... 5.5 SECONDS FOR CATS. [Peer reviewed] [American Conference of Governmental Industrial Hygienists. Documentation of the Threshold Limit Values and Biological Exposure Indices. 5th ed. Cincinnati, OH:American Conference of Governmental Industrial Hygienists, 1986. 124]

Mechanism of Action:

2-CHLOROBENZYLIDENEMALONONITRILE HAS 2 DISTINCT ... /MECHANISMS/ OF TOXICITY IN MICE; ONE, OF SHORT TERM DURATION, WHICH IS THE MORE TOXIC OF THE TWO, INVOLVES LIBERATION OF CYANIDE WITHIN THE BODY, AND IS REVERSED BY SODIUM THIOSULFATE; THE OTHER IS OF LONG-TERM DURATION, THE MECHANISM OF WHICH HAS NOT BEEN DETERMINED. [Peer reviewed] [JONES GR N, ISRAEL MS; NATURE (LONDON) 228 (5278): 1315 (1970)]

Interactions:

1. When CS is applied in a solvent, its effect on the cornea is very much influenced by the nature of the solvent, less injury resulting from solutions in trichloroethane or tri(2-ethylhexyl)phosphate than in methylene dichloroide, corn oil, or polyethylene glycol 300. [Peer reviewed] [Grant, W.M. Toxicology of the Eye. 3rd ed. Springfield, IL: Charles C. Thomas Publisher, 1986. 210]
2. WHEN SODIUM THIOSULFATE WAS GIVEN IN MULTIPLE INJECTIONS, IT PROTECTED MICE AGAINST DEATH BY PROPIONITRILE. [Peer reviewed] [WILLHITE CC, SMITH RP; TOXICOL APPL PHARMACOL 59 (3): 589-602 (1981)]
3. The toxic mechanism of nitriles and the effect of metabolic modifiers in mice were studied in relation to their physicochemical properties. All the test nitriles liberated cyanide both in vivo and in vitro, with the exception of benzonitrile, although the extent of liberation and the effect of carbon tetrachloride pretreatment on the mortality of animals differed among nitriles. From these results, test compounds were tentatively divided into 3 groups. In group 1, acute toxicity was greatly reduced by carbon tetrachloride pretreatment, in group 2, toxicity was not significantly changed or was somewhat enhanced, and in group 3, benzonitrile only, toxicity was clearly enhanced. The amount of cyanide was higher at death in the brains of mice given group 1 compounds, the level being comparable to that found in mice killed by dosing with potassium cyanide. The relation between log (1/LD50) and log p for the compounds in group 1 fitted a parabolic plot, while that for compounds in group 2 was linear. For most nitriles, the in vitro metabolism was inhibited when the incubation mixture contained either SKF-525A, carbon monoxide, or microsomes from mice treated with carbon tetrachloride. When mice were closed with ethyl alcohol, metabolic enhancement of nitriles was seen compared with the control. However, ethyl alcohol, when added to the incubation mixture, inhibited the in vitro metabolism of nitriles. /Nitriles/ [Peer reviewed] [Tanii H; Juzen Igakkai Zasshi 94 (4): 664-77 (1985)]

7.0 ENVIRONMENTAL FATE/EXPOSURE POTENTIAL

SUMMARY ▲

Environmental Fate/Exposure Summary:

2-Chlorobenzalmalononitrile is released directly to the environment through its use as a tear-gas and riot control agent. If released to the atmosphere as a dust or powder from its use as a riot control agent, it will settle to the ground via dry deposition. If released to water or soil, the major degradation process is expected to be hydrolysis. Aqueous hydrolysis experiments in seawater have determined hydrolysis half-lives of 281.7 min at 0 deg C and 14.5 min at 25 deg C. However, actual environmental degradation rates may be much slower because the rate at which 2-chlorobenzalmalononitrile dissolves in water can be very slow. 2-Chlorobenzalmalononitrile released to water could float and travel for considerable distances before it dissolves. Insufficient data are available to predict the importance of biodegradation. Exposure from its use as riot control agent occurs through inhalation and dermal contact. (SRC) [Peer reviewed]

POLLUTION SOURCES ▲

Artificial Sources:

2-Chlorobenzalmalononitrile's use as a tear-gas and riot control agent can release the compound directly to the environment through various forms of aerosol dispersal, followed by atmospheric settling (dry deposition) to the ground(1). [Peer reviewed] [(1) Harris BL et al; Kirk-Othmer Encycl Chem Technol 3rd ed. NY: John Wiley & Sons 5: 401 (1979)]

ENVIRONMENTAL FATE ▲

1. TERRESTRIAL FATE: A single application of 2-chlorobenzalmalononitrile to snow surfaces in a Norwegian forest was examined for a 28-day period(1); at the end of the 28-day period, more than 10% of the application remained(1); the compound did not penetrate more than 3 cm below the snow surface(1). Analysis of snow samples near a detonation of a 2-chlorobenzalmalononitrile tear gas grenade in a Norwegian forest found that detectable levels (0.3 ug) could be identified in snow 70 meters from the detonation site 29 days after the detonation(1). Dusts or powders of 2-chlorobenzalmalononitrile that have settled to the ground after its use as a riot control agent can remain active for as long as 5 days(2); if the compound was formulated with a silicone water repellent, it may persist for as long as 45 days(2). [Peer reviewed] [(1) Johnsen BA, Blanch JH; pp. 22-30 in Proc First World Congress, Med Soc Hyg Chem Warfare Toxicol Eval Pt 22 (1984) (2) Harris BL et al; Kirk-Othmer Encycl Chem Technol 3rd ed. NY: John Wiley & Sons 5: 401 (1979)]
2. TERRESTRIAL FATE: The major degradation process for 2-chlorobenzalmalononitrile in moist soil is expected to be hydrolysis(SRC). Actual environmental degradation rates may be much slower because the rate at which 2-chlorobenzalmalononitrile dissolves in water can be very slow(1). Insufficient data are available to predict the importance of biodegradation in soil. An estimated Koc value of 44 suggests that leaching in soil is likely to occur(2,SRC); however, 2-chlorobenzalmalononitrile that is dissolved in water will hydrolyze too fast for leaching to be important(SRC). [Peer reviewed] [(1) Demek MM et al; Behavior of Chemical Agents in Seawater. Edgewood Arsenal Technical Report EATR 4417. Task 1B662706A09501. Edgewood Arsenal, MD: Dept of the Army (1970) (2) Lyman WJ et al; Handbook of Chemical Property Estimation Methods NY: McGraw-Hill p. 4-9 (1982)]
3. AQUATIC FATE: The major degradation process for 2-chlorobenzalmalononitrile in water is expected to be hydrolysis(SRC). Aqueous hydrolysis experiments in seawater have determined hydrolysis half-lives of 281.7 min at 0 deg C and 14.5 min at 25 deg C(1). However, actual environmental degradation rates may be much slower because the rate at which 2-chlorobenzalmalononitrile dissolves in water can be very slow(1). 2-Chlorobenzalmalononitrile released to water could float and travel for considerable distances before it dissolves (1); once it is dissolved, hydrolysis will proceed rapidly and o-chlorobenzaldehyde has been detected as a hyrolysis product. Aquatic volatilization, adsorption to sediment, and bioconcentration are not expected to be important environmentally(SRC). [Peer reviewed] [(1) Demek MM et al; Behavior of Chemical Agents in Seawater. Edgewood Arsenal Technical Report EATR 4417. Task 1B662706A09501. Edgewood Arsenal, MD:

Dept of the Army (1970)]

4. ATMOSPHERIC FATE: Based upon a reported vapor pressure of 3.4X10-5 mm Hg at 25 deg C(1), 2-chlorobenzalmalononitrile could exist in both the vapor-phase and particulate-phase in the ambient atmosphere (2,SRC). Vapor-phase 2-chlorobenzalmalononitrile is expected to degrade in an average ambient atmosphere (estimated half-life of about 4.9 days) by reaction with photochemically produced hydroxyl radicals(3,SRC). Particulate-phase material can be physically removed from air by wet and dry deposition. 2-Chlorobenzalmalononitrile that is dissolved in water is susceptible to rapid hydrolysis(4); therefore, dissolution of the compound into clouds or rain will contribute to its atmospheric removal(SRC). [Peer reviewed] [(1) Windholz M; The Merck Index Tenth Edition. Rahway, NJ: Merck & Co p. 298-9 (1983) (2) Eisenreich SJ et al; Environ Sci Technol 15: 30-8 (1981) (3) Atkinson R; J Inter Chem Kinet 19: 799-828 (1987) (4) Demek MM et al; Behavior of Chemical Agents in Seawater. Edgewood Arsenal Technical Report EATR 4417. Task 1B662706A09501. Edgewood Arsenal, MD: Dept of the Army (1970)]

ENVIRONMENTAL TRANSFORMATIONS ▲

Abiotic Degradation:

1. The first-order hydrolysis rate constants of 2-chlorobenzalmalononitrile in seawater at 0, 15, and 25 deg C were experimentally determined to be 4.10X-5, 2.30X10-4, and 7.97X10-4 /sec, respectively(1); these rate constants correspond to respective half-lives of 281.7, 50.2, and 14.5 minutes(SRC). However, the degradation rate in water may be much longer than the hydrolysis rates would suggest(1); 2-chlorobenzalmalononitrile is produced as fine particles whose size and surface coatings greatly affect the rate at which it dissolves in water(1); 2-chlorobenzalmalononitrile released to water could float and travel for considerable distances before it dissolves (1); once it is dissolved, hydrolysis will proceed rapidly(1). o-Chlorobenzaldehyde was detected as a hydrolysis product. [Peer reviewed] [(1) Demek MM et al; Behavior of Chemical Agents in Seawater. Edgewood Arsenal Technical Report EATR 4417. Task 1B662706A09501. Edgewood Arsenal, MD: Dept of the Army (1970)]
2. The rate constant for the vapor-phase reaction of 2-chlorobenzalmalononitrile with photochemically produced hydroxyl radicals has been estimated to be 3.30X10-12 cu cm/molecule- sec at 25 deg C which corresponds to an atmospheric half-life of about 4.9 days at an atmospheric concn of 5X10+5 hydroxyl radicals per cu cm(1,SRC). [Peer reviewed] [(1) Atkinson R; J Inter Chem Kinet 19: 799-828 (1987)]

ENVIRONMENTAL TRANSPORT ▲

Bioconcentration:

Based upon an estimated log Kow of 1.849(1), the bioconcentration factor (BCF) for 2-chlorobenzalmalononitrile can be estimated to be 41.6 from a recommended regression-derived equation (2,SRC). This BCF value suggests that bioconcentration in aquatic organisms may not be important environmentally(SRC). [Peer reviewed] [(1) USEPA; PCGEMS (Graphical Exposure Modeling System) CLOGP-Version April 1987 (1987) (2) Lyman WJ et al; Handbook of Chemical Property Estimation Methods NY: McGraw-Hill p. 5-4 (1982)]

Soil Adsorption/Mobility:

Based upon an estimated log Kow of 1.849(1), the Koc for 2-chlorobenzalmalononitrile can be estimated to be 44 from a regression equation derived from chlorinated aromatics(2,SRC). This estimated Koc value suggests that 2-chlorobenzalmalononitrile will be highly mobile in soil(3). [Peer reviewed] [(1) USEPA; PCGEMS (Graphical Exposure Modeling System) CLOGP-Version April 1987 (1987) (2) Lyman WJ et al; Handbook of Chemical Property Estimation Methods NY: McGraw-Hill p. 4-9 (1982) (3) Swann RL et al; Res Rev 85: 16-28 (1983)]

Volatilization from Soil/Water:

The Henry's Law constant for 2-chlorobenzalmalononitrile can be estimated to be 1.02X10-8 atm-cu m/mole using a structure estimation method(1,SRC). This value of Henry's Law constant indicates that a compound is essentially non-volatile from water(2). [Peer reviewed] [(1) Hine J, Mookerjee PK; J Org Chem 40: 292-8 (1975) (2) Lyman WJ et al; Handbook of Chemical Property Estimation Methods NY: McGraw-Hill pp. 15-15 to 15-29 (1982)]

HUMAN EXPOSURE ▲

Probable Routes of Human Exposure:

2-Chlorobenzalmalononitrile is used as a tear-gas agent for riot control(1); its use as a tear-gas agent involves its dissemination as a cloud of dust or powder, or as an aerosol generated thermally from pyrotechnic compositions(1). Routes of exposures are dermal contact and inhalation. [Peer reviewed] [(1) Harris BL et al; Kirk-Othmer Encycl Chem Technol 3rd ed. NY: John Wiley & Sons 5: 401 (1979)]

8.0 EXPOSURE STANDARDS AND REGULATIONS

STANDARDS AND REGULATIONS ▲

Immediately Dangerous to Life or Health: 2 mg/cu m [QC reviewed] [NIOSH. NIOSH Pocket Guide to Chemical Hazards. DHHS (NIOSH) Publication No. 97-140. Washington, D.C. U.S. Government Printing Office, 1997. 62]

OCCUPATIONAL PERMISSIBLE LEVELS ▲

OSHA Standards:

1. Permissible Exposure Limit: Table Z-1 8-hr Time Weighted Avg: 0.05 ppm (0.4 mg/cu m). [QC reviewed] [29 CFR 1910.1000 (7/1/98)]
2. Vacated 1989 OSHA PEL Ceiling limit 0.05 ppm (0.4 mg/cu m), skin designation, is still enforced in some states. [QC reviewed] [NIOSH. NIOSH Pocket Guide to Chemical Hazards. DHHS (NIOSH) Publication No. 97-140. Washington, D.C. U.S. Government Printing Office, 1997. 361]

NIOSH Recommendations: Ceiling value: 0.05 ppm (0.4 mg/cu m), skin [QC reviewed] [NIOSH. NIOSH Pocket Guide to Chemical Hazards. DHHS (NIOSH) Publication No. 97-140. Washington, D.C. U.S. Government Printing Office, 1997. 62]

Threshold Limit Values:

1. Ceiling Limit 0.05 ppm, skin [QC reviewed] [American Conference of Governmental Industrial Hygienists. Threshold Limit Values (TLVs) for Chemical Substances and Physical Agents Biological Exposure Indices for 1998. Cincinnati, OH: ACGIH, 1998. 25]
2. A4. A4= Not classifiable as a human carcinogen. [QC reviewed] [American Conference of Governmental Industrial Hygienists. Threshold Limit Values (TLVs) for Chemical Substances and Physical Agents Biological Exposure Indices for 1998. Cincinnati, OH: ACGIH, 1998. 25]

OTHER STANDARDS AND REGULATIONS ▲

RCRA Requirements:

1. D003; A solid waste containing a cyanide cmpd may become characterized as a hazardous waste when subjected to testing for reactivity as stipulated in 40 CFR 261.23, and if so characterized, must be managed as a hazardous

waste. /Cyanide cmpd/ [Peer reviewed] [40 CFR 261.23 (7/1/91)]
2. P030; As stipulated in 40 CFR 261.33, when cyanides, not otherwise specified, as commercial chemical products or manufacturing chemical intermediates or off-specification commercial chemical products or manufacturing chemical intermediates, become wastes, they must be managed according to federal and/or state hazardous waste regulations. Also defined as a hazardous waste is any container or inner liner used to hold these wastes or any residue, contaminated soil, water, or other debris resulting from the cleanup of a spill, into water or on dry land, of these wastes. Generators of small quantities of these wastes may qualify for partial exclusion from hazardous waste regulations (40 CFR 261.5(e)). /Cyanides, not otherwise specified/ [Peer reviewed] [40 CFR 261.33 (7/1/91)]

9.0 MONITORING AND ANALYSIS METHODS

Sampling Procedures:

1. NIOSH Method 304. Analyte: 2-Chlorobenzylidene malononitrile. Matrix: Air. Procedure: Filter/sorbent collection, extraction with 20% methylene chloride in hexane. Flow rate: 1.5 l/min. Sample size: 90 liters. [Peer reviewed] [U.S. Department of Health, Education Welfare, Public Health Service. Center for Disease Control, National Institute for Occupational Safety Health. NIOSH Manual ofAnalytical Methods. 2nd ed. Volumes 1-7. Washington, DC: U.S. Government Printing Office, 1977-present. 304]
2. NIOSH Method: 304. Analyte: o-Chlorobenzylidene malononitrile. Matrix: Air. Procedure: Filter/sorbent collection, extraction with 20% methylene chloride in hexane. Flow Rate: 1.5 l/min. Sample Size: 90 liters. [Peer reviewed] [U.S. Department of Health, Education Welfare, Public Health Service. Center for Disease Control, National Institute for Occupational Safety Health. NIOSH Manual ofAnalytical Methods. 2nd ed. Volumes 1-7. Washington, DC: U.S. Government Printing Office, 1977-present.,p. V5 304-1]

Analytical Laboratory Methods:

1. CAN BE EXTRACTED FROM CHEMICAL PROTECTION SPRAYS WITH METHANOL. ANALYSIS IS BY GC/MS. [Peer reviewed] [NOWICKI J; J FORENSIC SCI 27 (3): 704 (1982)]
2. REVERSED-PHASE HPLC IS DESCRIBED. A CONCENTRATION OF 1-10 NG CAN BE DETECTED AT 313 NM. [Peer reviewed] [RAGHUVEERAN CD, MALHOTRA RC; J CHROMATOGR 240 (1): 243 (1982)]
3. NIOSH Method: 304. Analyte: o-Chlorobenzylidene malononitrile. Matrix: Air. Procedure: HPLC. Method Evaluation: Method was validated over the range of 0.1472 to 0.819 mg/cu m using a 90 liter sample. Method detection limit: 0.3 ug/sample. Precision (CVt): 0.102. Interferences: No specific interferences. [Peer reviewed] [U.S. Department of Health, Education Welfare, Public Health Service. Center for Disease Control, National Institute for Occupational Safety Health. NIOSH Manual ofAnalytical Methods. 2nd ed. Volumes 1-7. Washington, DC: U.S. Government Printing Office, 1977-present.,p. V5 304-1]

Clinical Laboratory Methods:

CONCENTRATIONS OF 2-CHLOROBENZALMALONONITRILE & ITS METABOLITES WERE DETERMINED IN BLOOD BY GC. [Peer reviewed] [PARADOWSKI M; POL J PHARMACOL PHARM 31 (6): 563 (1979)]

10.0 ADDITIONAL REFERENCES

Special Reports:

1. JONES G RN; CS (2,CHLOROBENZYLIDENE MALONONITRILE) AND ITS CHEMICAL RELATIVES; NATURE (LOND) 235 (5336): 257 (1972). THIS REVIEW ARTICLE SURVEYS THE PRINCIPAL ASPECTS OF THE CHEMICAL PROPERTIES OF BENZYLIDENE MALONONITRILES AND THEIR EFFECTS ON THE INTERACTIONS WITH LIVING ORGANISMS (HUMAN AND ANIMAL).
2. DMITRIEV VI; VOEN-MED ZH 1: 88 (1974). A REVIEW OF THE HUMAN TOXICITY OF O-CHLOROBENZALMALONONITRILE, USED BY THE USA ARMY IN INDOCHINA, IS DESCRIBED.
3. Kaplita PV and Smith RP; Toxicol Appl Pharmacol 84 (3): 533-540 (1986). Pathways for the bioactivation of aliphatic nitriles to free cyanide in mice.

4. DHHS/NTP; Toxicology & Carcinogenesis Studies of CS (94% o-Chlorobenzalmalononitrile) in F344/N Rats and B6C3F1 Mice (Inhalation Studies)Technical Report Series No. 377 (1990) NIH Publication No. 90-2832

2-CHLOROBENZALMALONONITRILE

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9.0 MONITORING AND ANALYSIS METHODS

Sampling Procedures:

1. NIOSH Method 304. Analyte: 2-Chlorobenzylidene malononitrile. Matrix: Air. Procedure: Filter/sorbent collection, extraction with 20% methylene chloride in hexane. Flow rate: 1.5 l/min. Sample size: 90 liters.
2. NIOSH Method: 304. Analyte: o-Chlorobenzylidene malononitrile. Matrix: Air. Procedure: Filter/sorbent collection, extraction with 20% methylene chloride in hexane. Flow Rate: 1.5 l/min. Sample Size: 90 liters.

Analytical Laboratory Methods:

1. CAN BE EXTRACTED FROM CHEMICAL PROTECTION SPRAYS WITH METHANOL. ANALYSIS IS BY GC/MS.
2. REVERSED-PHASE HPLC IS DESCRIBED. A CONCENTRATION OF 1-10 NG CAN BE DETECTED AT 313 NM.
3. NIOSH Method: 304. Analyte: o-Chlorobenzylidene malononitrile. Matrix: Air. Procedure: HPLC. Method Evaluation: Method was validated over the range of 0.1472 to 0.819 mg/cu m using a 90 liter sample. Method detection limit: 0.3 ug/sample. Precision (CVt): 0.102. Interferences: No specific interferences.

Clinical Laboratory Methods:

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2-CHLOROBENZALMALONONITRILE

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5.0 TOXICITY/BIOMEDICAL EFFECTS

Document Outline

SUMMARY ▲

Antidote and Emergency Treatment:

1. Rapid support of respiration and circulation is essential to successful treatment of cyanide intoxication. Massive cyanide overdoses have survived with only good supportive care. Immediate attention should be directed toward assisted ventilation, administration of 100% oxygen, insertion of intravenous lines, and institution of cardiac monitoring. Obtain an arterial blood gas immediately and correct any severe metabolic acidosis (pH below 7.15). Oxygen (100%) should be used routinely in moderate or severely symptomatic patients even in the presence of a normal pO2, since 100% O2 increases O2 delivery, may reactivate cyanide-inhibited mitochondrial enzymes, and potentiates the effect of thiosulfate. Avoid mouth to mouth resuscitation during CPR in order to prevent self poisoning. /Cyanides/
2. Amyl nitrite perles are designed to produce 3% to 5% methemoglobinemia while an iv line is established for iv sodium nitrite. As a temporizing measure, the patient inhales the vapors until the sodium nitrite is ready. Because of the variability in methemoglobin production and the potential for cardiovascular collapse, this step may be omitted if sodium nitrite is readily available and the patient is not in extremis. Adequate ventilation and oxygenation are more important than administration of amyl nitrite. One perle (0.2 ml) is crushed and inhaled for 30 seconds every minute until iv nitrite is given. Sodium nitrite (3% solution), as 10 ml of a 3% solution (eg, 300 mg), is administered iv slowly over 4 minutes to produce a 20% methemoglobin level in adults. Children should receive 0.33 ml of the 3% solution per kilogram initially at an infusion rate of 2.5 ml/min, up to a maximum of 10 ml. Administer sodium nitrite doses to children on the basis of body weight, since fatal methemoglobinemia has occurred in children. /Cyanides/

TOXICITY EXCERPTS ▲

Human Toxicity Excerpts:

1. ... HUMAN VOLUNTEERS /WERE EXPOSED/ TO CS AEROSOLS DISPERSED FROM A 10% SOLUTION IN METHYLENE CHLORIDE, OR FROM PURE MOLTEN COMPOUND. ... 3 OF 4 MEN EXPOSED FOR 90 MINUTES AT 1.5 MG/CU M CS DEVELOPED HEADACHES, & 1 ... DEVELOPED SLIGHT EYE & NOSE IRRITATION. TWO ... EXPERIENCED HEADACHE FOR 24 HR FOLLOWING EXPOSURE. ... INCREASING TEMPERATURE & RELATIVE HUMIDITY AS WELL AS HYPERVENTILATION CAUSED DECREASE IN TOLERANCE TIME TO CS EFFECTS. MAJOR EXPOSURE SYMPTOMS WERE EYE IRRITATION, CONJUNCTIVITIS, LACRIMATION & SKIN BURNING.
2. TWENTY FIVE OF 28 WORKERS IN A CHEMICAL PLANT MANUFACTURING ORTHO-CHLOROBENZYLIDENE MALONONITRILE GAVE A HISTORY OF DERMATITIS INVOLVING THE ARMS AND NECK. TWO OF 25 WORKERS SHOWED POSITIVE PATCH TEST REACTIONS WHEN TESTED TO A 1:1000 DILUTION OF ORTHO-CHLOROBENZYLIDENE MALONONITRILE IN OLIVE OIL.
3. PULMONARY EDEMA COMPLICATED BY PNEUMONIA, HEART FAILURE & HEPATOCELLULAR DAMAGE WERE OBSERVED IN A 43 YR OLD MALE EXPOSED TO CS TEAR GAS.
4. A 4 MO OLD MALE INFANT DEVELOPED PNEUMONITIS FOLLOWING A PROLONGED EXPOSURE TO TEAR GAS. THE PAIENT HAD A PERSISTENT LEUKOCYTOSIS (WHITE BLOOD CELL COUNT 20000 TO 30000/CU MM) WITH A PREDOMINANCE OF LYMPHOCYTES ON PERIPHERAL BLOOD SMEAR.
5. ... A SIGNIFICANT SKIN SENSITIZING POTENTIAL TO CS EXISTS IN INDUSTRY WHERE THIS CHEMICAL IS HANDLED. THE RESULTING DERMATITIS INVOLVES MAINLY THE ARMS & NECKS.

Non-Human Toxicity Excerpts:

1. THE LETHAL CONCENTRATION OF 2-CHLOROBENZALMALONONITRILE TO RAINBOW TROUT WAS MORE THAN 0.1 MG/L FOR AN EXPOSURE PERIOD OF LESS THAN 1 WK.
2. IN ACUTE EXPOSURES OF RATS TO 2-CHLOROBENZALMALONONITRILE, BOTH THE CORTICAL & MEDULLARY REGIONS OF THE ADRENAL GLANDS SHOWED SIGNIFICANT CYTOCHEMICAL CHANGES. IP INJECTIONS OF 10 MG/KG & 20 MG/KG PRODUCED INCREASE IN PERIODIC ACID-SCHIFF, SUDANOPHILIC & ALKALINE PHOSPHATASE REACTIONS.
3. A DOSE-DEPENDENT INHIBITION OF CYTOCHROME OXIDASE, PYRUVATE DEHYDROGENASE COMPLEX, SUCCINATE DEHYDROGENASE, LACTATE DEHYDROGENASE, MALATE DEHYDROGENASE, & GLUTAMATE DEHYDROGENASE WAS OBSERVED IN RATS ADMINISTERED 10 MG/KG & 20 MG/KG, IP. IT ALSO HAS A STIMULATING EFFECT ON THE LACTIC ACID FORMATION IN RAT BRAIN DURING GLYCOLYSIS.
4. DAILY DOSES OF 8 & 16 MG/KG FOR 10 DAYS TO MICE SUPPRESSED THE HUMORAL IMMUNE RESPONSE TO SHEEP RED BLOOD CELLS. IN ADDITION TO THE DIRECT EFFECT, INCREASED CORTICOSTERONE LEVELS AT 16 MG/KG MAY BE INSTRUMENTAL IN BRINGING ABOUT IMMUNOSUPPRESSION.
5. MUTAGENICITY OF O-CHLOROBENZYLIDENE MALONONITRILE WAS TESTED IN AMES SALMONELLA/MICROSOME ASSAY WITH STRAINS TA 1535, TA 1537, TA 1538, TA 98, & TA 100. WITHOUT PREINCUBATION DOUBLING OF REVERTANTS WAS SEEN IN STRAIN TA 100 AT CONCENTRATIONS OF 1000 & 2000 UG/PLATE. A SLIGHT INCREASE OCCURRED WITH PREINCUBATION IN TA 100 AT CONCENTRATIONS OF 100 & 500 UG.

6. FOLLOWING EXPOSURE TO 150 MG/CU M O-CHLOROBENZYLIDENE MALONONITRILE FOR 2 HR, 2 ANIMALS (HAMSTERS) OUT OF 240 DIED OF BRONCHOPNEUMONIA. EXPOSURE OF 106 HAMSTERS AND 120 RATS TO 480 MG/CU M RESULTED IN THE DEATHS OF 31 HAMSTERS AND 9 RATS. ANIMALS THAT DIED WITHIN 48 HR OF EXPOSURE HAD MODERATELY SEVERE PULMONARY CONGESTION, HEMORRHAGES AND OCCASIONALLY EDEMA. ACUTE RENAL CORTICAL AND MEDULLARY TUBULAR NECROSIS WAS A COMMON FINDING. IN SOME RATS THERE WAS MIDZONAL HEPATOCELLULAR NECROSIS.
7. PYROTECHNICALLY GENERATED (GRENADE) O-CHLOROBENZYLIDENE MALONONITRILE WAS GIVEN BY INHALATION TO CATS IN CONCN BETWEEN 460 AND 1040 MG/CU M FOR 1 HR. RESP DEPRESSION, POSSIBLY REFLEX IN NATURE, REGULARLY OCCURRED WHEN THE MATERIAL WAS GIVEN VIA THE UPPER RESP TRACT, AND RESP STIMULATION OCCURRED WHEN IT WAS GIVEN VIA TRACHEAL CANNULA.
8. O-CHLOROBENZYLIDENE MALONONITRILE PRODUCED A 50% DEPRESSION OF RESP RATE IN MICE AFTER A 1 MIN EXPOSURE.
9. RABBIT EYES WERE CONTAMINATED WITH CS IN SOLN (0.5 TO 10% IN POLYETHYLENE GLYCOL 300), AS A SOLID (0.5 TO 5 MG), AND AS A PYROTECHNICALLY GENERATED SMOKE (15 MIN EXPOSURE TO 6 G/CU M). CS CAUSED LACRIMATION, BLEPHARITIS AND CONJUNCTIVAL IRRITATION BY ALL THE METHODS OF CONTAMINATION, THE SEVERITY AND DURATION OF WHICH INCR WITH THE AMT OF MATERIAL APPLIED.
10. NO INCR IN LUNG TUMORS WAS OBSERVED IN MICE OR RATS EXPOSED TO CT'S OF 50 AND 500 MG O-CHLOROBENZYLIDENEMALONONITRILE MIN/CU M 5 DAYS A WEEK FOR 4 WEEKS. EXPOSURE CONCN WERE ABOUT 21 MG/CU M, AND TOTAL CT'S WERE, THUS, 1000 AND 10000 MG MIN/CU M.
11. PREGNANT RATS AND RABBITS WERE EXPOSED TO O-CHLOROBENZYLIDENE MALONONITRILE AEROSOLS AT 6, 20, AND 60 MG/CU M FOR 5 MIN ON DAYS 6-15 AND 6-18 OF PREGNANCY, RESPECTIVELY, AND RATS WERE INJECTED IP AT 20 MG/KG ON DAYS 6, 8, 10, 12, OR 14 OF PREGNANCY, BUT IT WAS NOT EMBRYOLETHAL OR TERATOGENIC AND THERE WAS NO EFFECT ON THE NUMBER OF IMPLANTATIONS OR LITTERS PRODUCED.
12. CS was found to bind to nuclear proteins but not to DNA in rats. In a study in which Sprague Dawley rats were administered an intraperitoneal injection of 13 mg/kg of CS with a (14)C-label at the benzylic carbon, very little radioactivity was found in liver DNA 8 or 75 hours after the animals were dosed. However, a considerable amount of radioactivity was observed in nuclear proteins isolated from liver and kidney at these times. The binding to protein may have occurred between the carbons at the double bond in CS and the sulfhydryl groups of proteins. Additionally, the binding could have occurred between o-chlorobenzaldehyde (a hydrolysis product) and the amino groups of proteins.
13. Results of bacterial mutagenicity assays with CS were generally negative, although there have been reports of equivocal to weakly positive responses observed in Salmonella strain TA100 in the absence of S9 activation and in TA97 with S9. Administration of CS in feed did not result in an increase in sex-linked recessive lethal mutations in germ cells of male Drosophila. In mammalian cell cultures, positive results were reported for gene mutation induction in L5178Y mouse lymphoma cells, and cytogenetic tests conducted by the National Toxicology Program in Chinese hamster ovary cells were positive for induction of sister chromatid exchanges and chromosomal aberrations in the presence and absence of S9. However, no increase /was observed/ in micronucleated polychromatic erythrocyres in the bone marrow of mice administered CS either by intraperitoneal injection or orally.

14. The responses in Salmonella gene mutation tests with 94% o-chlorobenzalmalononitrile (with 5% Cab-O-Sil colloidal silica; 1% hexamethyldisilizane) were equivocal in one laboratory for strain TA100 in the absence of exogenous metabolic activation (S9) and equivocal in another laboratory for TA97 with (S9); in all other strains tested. 94% o-Chlorobenzalmalononitrile (with 5% Cab-O-Sil colloidal silica; 1% hexamethyldisilizane) was clearly negative with or without (S9). 94% o-Chlorobenzalmalononitrile (with 5% Cab-O-Sil colloidal silica; 1% hexamethyldisilizane) induced trifluorothymidine resistance in mouse L5178Y/TK lymphoma cells in the absence of (S9); it was not tested with (S9). 94% o-Chlorobenzalmalononitrile (with 5% Cab-O-Sil colloidal silica; 1% hexamethyldisilizane) induced both sister chromatid exchanges and chromosomal aberrations in CHO cells with and without S(9).
15. STRUCTURE-ACTIVITY RELATIONSHIPS WERE QUALITATIVELY & QUANTITIVELY EXAMINED FOR 56 COMPOUNDS (EG DERIVATIVES OF PROPIONITRILE, ACRYLONITRILE, & CYSTEAMINE) WHICH CAUSED DUODENAL ULCER &/OR ADRENOCORTICAL NECROSIS IN RATS. ULCEROGENIC ACTIVITY WAS MOST INTENSE IN THE CARBONITRILES ATTACHED TO 2 OR 3-C BACKBONES.

TOXICITY VALUES ▲

Non-Human Toxicity Values:

1. LD50 Rat iv 28 mg/kg
2. LD50 Rat ip 48 mg/kg
3. LD50 Rat (male) oral 1366 mg/kg
4. LD50 Rat (female) oral 1284 mg/kg

Ecotoxicity Values:

1. LC50 Rainbow trout 1.28 mg/l/12 hr. /Conditions of bioassay not specified/
2. LC50 RAINBOW TROUT > 0.1 MG/L < 1 WK.

National Toxicology Program Reports:

1. Toxicology and carcinogenesis studies were conducted by exposing 50 F344/N rats and 50 B6C3F1 mice of each sex to ... (94% o-chlorobenzalmalononitrile) /by inhalation/. ... Exposure concentrations for the 2 yr studies were 0, 0.075, 0.25, or 0.75 mg/cu m for 6 hr/day, 5 days/wk for 105 wk for groups of 50 rats of each sex. Groups of 50 mice of each sex were exposed to 0, 0.75, or 1.5 mg/cu m on the same schedule. ... Under the conclusions of these inhalation studies, there was no evidence of carcinogenic activity ... for male or female F344/N rats exposed to 0.075, 0.25, or 0.75 mg/cu m for 2 yr. There was no evidence of carcinogenic activity for male or female B6C3F1 mice exposed to 0.75 or 1.5 mg/cu m in air for up to 2 yr.
2. Toxicology and carcinogenesis studies were conducted by exposing groups of F344/N rats and B6C3F1 mice of each sex for 6 hours per day, 5 days per week for 2 weeks, 13 weeks, or 2 years, to a CS2 (94% o-chlorobenzlmalonitrile [CS]; 5% Cab-O-Sil colloidal silica; 1% hexamethyldissilizane), aerosol. ... No compound-related clinical signs were observed. No significant differences in survival were seen for any group of rats or mice of either sex. ... Compound-related nonneoplastic lesions occurred in the nasal passage of exposed rats and mice. In exposed rats, hyperplasia and squamous metaplasia of the respiratory epithelium and degeneration of the olfactory epithelium with ciliated columnar and/or squamous metaplasia were observed. Focal chronic inflammation and proliferation of the periosteum of the turbinate bones were increased slightly in rats at the top exposure concentration. Suppurative inflammation with hyperplasia and squamous metaplasia of the respiratory epithelium occurred in exposed mice. The were no compound-related increased incidences of neoplasms in rats or mice. ... In exposed female

mice, there were pronounced decreases in the incidences of adenomas of the pituitary pars distalis (control, 13/47; 0.75 mg/cu m, 5/46; 1.5 mg/cu m, 1/46) and decreased incidences of malignant lymphomas (21/50; 12/50; 8/50).

PHARMACOKINETICS ▲

Metabolism/Metabolites:

1. ... METABOLITE IN BLOOD OF CATS & RATS, TO WHICH CS, O-CHLOROBENZYLIDENE MALONONITRILE, HAD BEEN ADMINISTERED, HAS ... BEEN /IDENTIFIED/ ... AS O-CHLOROBENZYLMALONONITRILE. REDUCTION OF THE BENZYLIDENE DOUBLE BOND, WHICH OCCURS IN THE ERYTHROCYTE CYTOPLASM, IS ASSOCIATED WITH THE DETOXIFICATION OF CS.
2. IN RABBITS ADMINISTERED IV DOSES 2 REACTIONS TAKE PLACE HYDROLYSIS & REDUCTION. O-CHLOROBENZALDEHYDE & MALONONITRILE ARE PRODUCTS OF HYDROLYSIS & O-CHLOROBENZYL MALONONITRILE IS PRODUCT OF REDUCTION. BIOTRANSFORMATION TAKES PLACE MAINLY IN THE BLOOD, BUT LIVER, IN CONTRAST TO KIDNEYS, IS ALSO IMPORTANT IN THE TRANSFORMATION. O-CHLOROBENZYLIDENE MALONONITRILE & ITS BASIC METABOLITES, O-CHLOROBENZALDEHYDE & O-CHLOROBENZYL MALONONITRILE HAVE SHORT HALF-LIVES IN THE BLOOD.
3. MICE RECEIVED O-CHLOROBENZYLIDENE MALONONITRILE BY IP INJECTION (0.5 LD50) OR BY AEROSOL EXPOSURE (20000 MG/MIN/CU M). INCREASED EXCRETION OF THIOCYANATE IN THE URINE WAS OBSERVED, INDICATING A TRANSFORMATION OF CS TO CYANIDE IN VIVO.
4. The fate of (3)H-ring labeled, (14(C-cyanide labeled, and (14C=C) side chain-labeled CS was studied in Porton rats given intraperitoneal or gavage doses ranging from 0.08 to 159 umol/kg. In most cases, the largest proportion (44%-100%) of the dose was eliminated in the urine. The major urinary metabolites identified were 2-chlorohippuric acid, 1-O-(2-chlorobenzyl)glucuronic acid, 2-chlorobenzyl cysteine, and 2-chlorobenzoic acid. Minor metabolites identified included 2-chlorobenzyl alcohol and 2-chlorophenyl-2-cyanopropionate.

Biological Half-Life:

... CATS & RATS /WERE EXPOSED/ TO CS AEROSOL ... ABSORPTION OF THE COMPOUND /OCCURRED/ ... IN THE BLOOD. ... THE HALF-LIFE ... IN THE BLOOD /WAS/ ... 5.5 SECONDS FOR CATS.

Mechanism of Action:

2-CHLOROBENZYLIDENEMALONONITRILE HAS 2 DISTINCT ... /MECHANISMS/ OF TOXICITY IN MICE; ONE, OF SHORT TERM DURATION, WHICH IS THE MORE TOXIC OF THE TWO, INVOLVES LIBERATION OF CYANIDE WITHIN THE BODY, AND IS REVERSED BY SODIUM THIOSULFATE; THE OTHER IS OF LONG-TERM DURATION, THE MECHANISM OF WHICH HAS NOT BEEN DETERMINED.

Interactions:

1. When CS is applied in a solvent, its effect on the cornea is very much influenced by the nature of the solvent, less injury resulting from solutions in trichloroethane or tri(2-ethylhexyl)phosphate than in methylene dichloroide, corn oil, or polyethylene glycol 300.

2. WHEN SODIUM THIOSULFATE WAS GIVEN IN MULTIPLE INJECTIONS, IT PROTECTED MICE AGAINST DEATH BY PROPIONITRILE.
3. The toxic mechanism of nitriles and the effect of metabolic modifiers in mice were studied in relation to their physicochemical properties. All the test nitriles liberated cyanide both in vivo and in vitro, with the exception of benzonitrile, although the extent of liberation and the effect of carbon tetrachloride pretreatment on the mortality of animals differed among nitriles. From these results, test compounds were tentatively divided into 3 groups. In group 1, acute toxicity was greatly reduced by carbon tetrachloride pretreatment, in group 2, toxicity was not significantly changed or was somewhat enhanced, and in group 3, benzonitrile only, toxicity was clearly enhanced. The amount of cyanide was higher at death in the brains of mice given group 1 compounds, the level being comparable to that found in mice killed by dosing with potassium cyanide. The relation between log (1/LD50) and log p for the compounds in group 1 fitted a parabolic plot, while that for compounds in group 2 was linear. For most nitriles, the in vitro metabolism was inhibited when the incubation mixture contained either SKF-525A, carbon monoxide, or microsomes from mice treated with carbon tetrachloride. When mice were closed with ethyl alcohol, metabolic enhancement of nitriles was seen compared with the control. However, ethyl alcohol, when added to the incubation mixture, inhibited the in vitro metabolism of nitriles. /Nitriles/

2-CHLOROBENZALMALONONITRILE

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7.0 ENVIRONMENTAL FATE/EXPOSURE POTENTIAL

Document Outline

SUMMARY ▲

Environmental Fate/Exposure Summary:

2-Chlorobenzalmalononitrile is released directly to the environment through its use as a tear-gas and riot control agent. If released to the atmosphere as a dust or powder from its use as a riot control agent, it will settle to the ground via dry deposition. If released to water or soil, the major degradation process is expected to be hydrolysis. Aqueous hydrolysis experiments in seawater have determined hydrolysis half-lives of 281.7 min at 0 deg C and 14.5 min at 25 deg C. However, actual environmental degradation rates may be much slower because the rate at which 2-chlorobenzalmalononitrile dissolves in water can be very slow. 2-Chlorobenzalmalononitrile released to water could float and travel for considerable distances before it dissolves. Insufficient data are available to predict the importance of biodegradation. Exposure from its use as riot control agent occurs through inhalation and dermal contact. (SRC)

POLLUTION SOURCES ▲

Artificial Sources:

2-Chlorobenzalmalononitrile's use as a tear-gas and riot control agent can release the compound directly to the environment through various forms of aerosol dispersal, followed by atmospheric settling (dry deposition) to the ground(1).

ENVIRONMENTAL FATE ▲

1. TERRESTRIAL FATE: A single application of 2-chlorobenzalmalononitrile to snow surfaces in a Norwegian forest was examined for a 28-day period(1); at the end of the 28-day period, more than 10% of the application remained(1); the compound did not penetrate more than 3 cm below the snow surface(1). Analysis of snow samples near a detonation of a 2-chlorobenzalmalononitrile

tear gas grenade in a Norwegian forest found that detectable levels (0.3 ug) could be identified in snow 70 meters from the detonation site 29 days after the detonation(1). Dusts or powders of 2-chlorobenzalmalononitrile that have settled to the ground after its use as a riot control agent can remain active for as long as 5 days(2); if the compound was formulated with a silicone water repellent, it may persist for as long as 45 days(2).

2. TERRESTRIAL FATE: The major degradation process for 2-chlorobenzalmalononitrile in moist soil is expected to be hydrolysis(SRC). Actual environmental degradation rates may be much slower because the rate at which 2-chlorobenzalmalononitrile dissolves in water can be very slow(1). Insufficient data are available to predict the importance of biodegradation in soil. An estimated Koc value of 44 suggests that leaching in soil is likely to occur(2,SRC); however, 2-chlorobenzalmalononitrile that is dissolved in water will hydrolyze too fast for leaching to be important(SRC).
3. AQUATIC FATE: The major degradation process for 2-chlorobenzalmalononitrile in water is expected to be hydrolysis(SRC). Aqueous hydrolysis experiments in seawater have determined hydrolysis half-lives of 281.7 min at 0 deg C and 14.5 min at 25 deg C(1). However, actual environmental degradation rates may be much slower because the rate at which 2-chlorobenzalmalononitrile dissolves in water can be very slow(1). 2-Chlorobenzalmalononitrile released to water could float and travel for considerable distances before it dissolves(1); once it is dissolved, hydrolysis will proceed rapidly and o-chlorobenzaldehyde has been detected as a hyrolysis product. Aquatic volatilization, adsorption to sediment, and bioconcentration are not expected to be important environmentally(SRC).
4. ATMOSPHERIC FATE: Based upon a reported vapor pressure of 3.4X10-5 mm Hg at 25 deg C(1), 2-chlorobenzalmalononitrile could exist in both the vapor-phase and particulate-phase in the ambient atmosphere(2,SRC). Vapor-phase 2-chlorobenzalmalononitrile is expected to degrade in an average ambient atmosphere (estimated half-life of about 4.9 days) by reaction with photochemically produced hydroxyl radicals(3,SRC). Particulate-phase material can be physically removed from air by wet and dry deposition. 2-Chlorobenzalmalononitrile that is dissolved in water is susceptible to rapid hydrolysis(4); therefore, dissolution of the compound into clouds or rain will contribute to its atmospheric removal(SRC).

ENVIRONMENTAL TRANSFORMATIONS ▲

Abiotic Degradation:

1. The first-order hydrolysis rate constants of 2-chlorobenzalmalononitrile in seawater at 0, 15, and 25 deg C were experimentally determined to be 4.10X-5, 2.30X10-4, and 7.97X10-4 /sec, respectively(1); these rate constants correspond to respective half-lives of 281.7, 50.2, and 14.5 minutes(SRC). However, the degradation rate in water may be much longer than the hydrolysis rates would suggest(1); 2-chlorobenzalmalononitrile is produced as fine particles whose size and surface coatings greatly affect the rate at which it dissolves in water(1); 2-chlorobenzalmalononitrile released to water could float and travel for considerable distances before it dissolves(1); once it is dissolved, hydrolysis will proceed rapidly(1). o-Chlorobenzaldehyde was detected as a hydrolysis product.
2. The rate constant for the vapor-phase reaction of 2-chlorobenzalmalononitrile with photochemically produced hydroxyl radicals has been estimated to be 3.30X10-12 cu cm/molecule- sec at 25 deg C which corresponds to an atmospheric half-life of about 4.9 days at an atmospheric concn of 5X10+5 hydroxyl radicals per cu cm(1,SRC).

ENVIRONMENTAL TRANSPORT ▲

Bioconcentration:

Based upon an estimated log Kow of 1.849(1), the bioconcentration factor (BCF) for 2-chlorobenzalmalononitrile can be estimated to be 41.6 from a recommended regression-derived equation(2,SRC). This BCF value suggests that bioconcentration in aquatic organisms may not be important environmentally(SRC).

Soil Adsorption/Mobility:

Based upon an estimated log Kow of 1.849(1), the Koc for 2-chlorobenzalmalononitrile can be estimated to be 44 from a regression equation derived from chlorinated aromatics(2,SRC). This estimated Koc value suggests that 2-chlorobenzalmalononitrile will be highly mobile in soil(3).

Volatilization from Soil/Water:

The Henry's Law constant for 2-chlorobenzalmalononitrile can be estimated to be 1.02X10-8 atm-cu m/mole using a structure estimation method(1,SRC). This value of Henry's Law constant indicates that a compound is essentially non-volatile from water(2).

HUMAN EXPOSURE ▲

Probable Routes of Human Exposure:

2-Chlorobenzalmalononitrile is used as a tear-gas agent for riot control(1); its use as a tear-gas agent involves its dissemination as a cloud of dust or powder, or as an aerosol generated thermally from pyrotechnic compositions(1). Routes of exposures are dermal contact and inhalation.

2-CHLOROBENZALMALONONITRILE

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8.0 EXPOSURE STANDARDS AND REGULATIONS

Document Outline

STANDARDS AND REGULATIONS ▲

Immediately Dangerous to Life or Health: 2 mg/cu m

OCCUPATIONAL PERMISSIBLE LEVELS ▲

OSHA Standards:

1. Permissible Exposure Limit: Table Z-1 8-hr Time Weighted Avg: 0.05 ppm (0.4 mg/cu m).
2. Vacated 1989 OSHA PEL Ceiling limit 0.05 ppm (0.4 mg/cu m), skin designation, is still enforced in some states.

NIOSH Recommendations: Ceiling value: 0.05 ppm (0.4 mg/cu m), skin

Threshold Limit Values:

1. Ceiling Limit 0.05 ppm, skin
2. A4. A4= Not classifiable as a human carcinogen.

OTHER STANDARDS AND REGULATIONS ▲

RCRA Requirements:

1. D003; A solid waste containing a cyanide cmpd may become characterized as a hazardous waste when subjected to testing for reactivity as stipulated in 40 CFR 261.23, and if so characterized, must be managed as a hazardous waste. /Cyanide cmpd/
2. P030; As stipulated in 40 CFR 261.33, when cyanides, not otherwise specified, as commercial chemical products or manufacturing chemical intermediates or off-specification commercial chemical products or manufacturing chemical intermediates, become wastes, they must be

managed according to federal and/or state hazardous waste regulations. Also defined as a hazardous waste is any container or inner liner used to hold these wastes or any residue, contaminated soil, water, or other debris resulting from the cleanup of a spill, into water or on dry land, of these wastes. Generators of small quantities of these wastes may qualify for partial exclusion from hazardous waste regulations (40 CFR 261.5(e)). /Cyanides, not otherwise specified/